

## University of Groningen

### Microscopic studies of boulder clays

Veenstra, Hemmo Jan

**IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.**

*Document Version*

Publisher's PDF, also known as Version of record

*Publication date:*

1963

[Link to publication in University of Groningen/UMCG research database](#)

*Citation for published version (APA):*

Veenstra, H. J. (1963). *Microscopic studies of boulder clays*. s.n.

**Copyright**

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license. More information can be found on the University of Groningen website: <https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment>.

**Take-down policy**

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

*Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.*

The present study shows that three types of boulder clay may be distinguished in the Netherlands. This may be based on any one of the following sources of information: colour, counting of erratics, grain size analysis, heavy mineral analysis, light mineral analysis, roundness and frosting of the quartz grains and microfossils, that lead to the same classification. These results are in accordance with the findings of De Ridder and Wiggers (1956), who based themselves on grain size analyses only.

The three types of boulder clay are:

1. grey or brown boulder clay in the northern part,
2. brown, yellow, green or black boulder clay in the central and eastern part, and
3. red boulder clay in the northern and central part of the Netherlands.

As described in part I, the petrographical analyses of two fractions, 0.42—0.85 mm and 0.85—2.00 mm show that the quartz percentage of the grey Saale boulder clay is higher (fine fr. 80 %, coarse fr. 60 %) than that of the Weichsel boulder clay (fine fr. 60 %, coarse fr. 30 %) and this in turn is higher than that of the red Saale boulder clay (fine fr. 40 %, coarse fr. 20 %).

In the diagrams (figs. 21—22) the composition of the light minerals in the Warthe boulder clay samples falls within the distribution of the Saale samples.

Originally the Warthe moraines were considered to testify to the existence of a separate ice age. Investigations of the last quarter century have led to the conclusion that the so-called Warthe glaciation is merely a recessional stage of the Saale glaciation. This present confirmation renders this view almost certain.

The roundness of the quartz grains shows that the Weichsel boulder clay and the Saale red boulder clay possess a greater amount of angular quartz grains than the grey Saale boulder clay.

Another observation in all the boulder clays is that the number of angular quartz grains is proportional to the number of crystalline fragments.

Counting of the frosted quartz grains reveals that the Warthe boulder clay contains a higher percentage of frosted grains than the Saale boulder clays.

This might be construed as showing that they do not belong to the same ice age. But the samples from the southern margin of the Saale ice-sheet also show a high amount of frosted quartz grains. The Warthe, after all, is a southern margin of a recessional stage and the similarity as to frosted grains with the outer limit of the Saale ice is thus understandable. This high percentage of frosted grains seems to be caused by an admixture of fluvioglacial or preglacial sediments with a high content of frosted grains. It seems probable, however, that the frosting of the quartz grains in the majority of the other samples was caused by chemical reactions with calcium bicarbonate or — hydroxide, occurring in boulder clay with a high lime-content.

In the finer fractions more rounded quartz grains and a higher percentage of frosted grains are found, the first possibly caused by addition of coarse angular grains to the sediment or by chemical attack of the fine angular grains which became subangular in this way, the second by selective chemical processes along cracks in the boulder clay, which attacked the smaller grains more severely.

As in all the samples only a part of the grains is frosted, certainly selective processes act a part.

In the grey Saale and Weichsel boulder clays Cretaceous microfossils are found, whereas the red boulder clay, which occurs in lenticular masses in the grey Saale boulder clay, contains Silurian fossils only.

In both cases Bryozoa can be used to discover the source area of the microfaunal assemblage. These Bryozoa are described in detail in part II of this treatise.

It appears that the Bryozoa enclosed in the normal grey boulder clays of the Saale and Weichsel glaciations consist of Maestrichtian and Danian fossils originating from

Denmark. The Silurian Bryozoa consist mainly of Upper Ordovician fossils and some Gotlandian ones, indicating a source area somewhere between Estonia and Gotland.

Concerning the age of the red boulder clay it may be remarked that the fresh state of the erratics and the position of the red lenses in the upper part of the normal boulder clay in the Netherlands and the northwestern part of Germany do not support the opinion of some authors that it is material of Elster age. Therefore it seems probable that the red boulder clay was first deposited in early Saalian times in the eastern part of the Baltic, which region is indicated by the erratics and the microfossils. Later, as the Scandinavian ice-sheet extended further to the east, it flowed from there towards the west and thus reached the Netherlands, it tended to pick up masses of the earlier deposits, which are now found as lenses in the upper (= later) part of the grey boulder clay.

It appears that the Saale boulder clay possesses a smaller amount of recognizable Danian Bryozoa than the Weichsel boulder clay. This is probably caused by weathering processes, which had more opportunity to attack the delicate calcareous Danian Bryozoa in the earlier (Saale) boulder clay, leaving more the stouter stems of the Maestrichtian beds.

The absolute microfossil-content of the Weichsel boulder clay is also far greater, because the distance away from the Cretaceous outcrops was smaller than from the Saale boulder clay studied and because the time available for weathering was shorter.

In about thirty samples of grey boulder clay of Saalian and Weichselian age Upper Cretaceous Foraminifera were found and in a few samples Tertiary ones also. So three different sources of Foraminifera may be distinguished:

1. the Upper Cretaceous of Denmark,
2. the Tertiary of Denmark and Germany, and
3. the Upper Cretaceous of the Münster Basin in Germany.

The microfossils prove that the main direction of the ice in NW.-Germany was the same during the Saale and the Weichsel glaciation, as it must have passed the Danish archipelago to pick up similar microfaunal assemblages.

An advantage of the method described in this treatise is that even small samples of 150 grammes are sufficient, so that material from borings can be identified instead of needing an excavation. Moreover, these small samples can give quicker and more detailed information than the counting of erratics.

140,  
1953